Zooplankton Distribution Across the Shelf Break on the Southeast Shoal of the Newfoundland Grand Banks in May 1981

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ZOOPLANKTON DISTRIBUTION ACROSS THE SHELF BREAK ON THE SOUTHEAST SHOAL OF THE NEWFOUNDLAND GRAND BANKS IN MAY 1981

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ABSTRACT

Gardner, G. T., and E. T. Howell. 1983. Zooplankton distribution across the shelf break on the Southeast Shoal of the Newfoundland Grand Banks in May 1981. Can. MS Rep. Fish. Aquat. Sci. 1724: iv + 61 p.

In May 1981, a series of zooplankton samples was collected at twenty-seven stations positioned on a grid arrayed across the Southeast Shoal of the Newfoundland Grand Banks. The shelf zooplankton community was neritic in nature, and characterized by a high (almost 100% in some samples) proportion of gelatinous zooplankters, particularly Pleurobrachia pileus. The slope stations were distinct and dominated by non-gelatinous forms, particularly copepods. The primary influence on community composition of net zooplankton is thus station position with respect to the shelf break and its associated front. The zooplankton distribution patterns suggest that changes in zooplankton community composition could be used to infer the extent and nature of intrusions of slope water onto the shelf. Such intrusions may be important to the maintenance of high levels of primary and secondary productivity on the continental shelf.

Key words: zooplankton, distribution, shelf break, Southeast Shoal.

RÉSUMÉ

Gardner, G. T., and E. T. Howell. 1983. Zooplankton distribution across the shelf break on the Southeast Shoal of the Newfoundland Grand Banks in May 1981. Can. MS Rep. Fish. Aquat. Sci. 1724: iv + 61 p.

En mai 1981, une série d'échantillons de zooplancton ont été recueillis à vingt-sept stations situées s r une grille disposée en travers du haut-fond du sud-est des Grands bancs de Terre-Neuve. La communité zooplanctonique de la plate-forme était néritique et caractérisée par une forte proportion (presque 100% dans certains échantillons) d'organismes zooplanctoniques gélatineux, en particulier Pleurobrachia pileus. Les stations au niveau de la pente continentale étaient distinctes et dominées par des formes non gélatineuses, en particulier des copépodes. Par conséquent, la principale influence sur la composition des communautés en microzooplancton est la situation de la station par rapport au rebord de la plate-forme et au front qui lui est associé. Les régimes de distribution du zooplancton donnent à penser que les changements dans la composition zooplanctonique des communautés pourraient être utilisés pour déduire l'étendue et la nature des intrusions d'eau de la pente continentale sur la plate-forme. Ces intrusions peuvent être importantes pour le maintien des niveaux élevés de productivité primaire et secondaire sur la plate-forme continentale.

INTRODUCTION

The continental shelf east of Newfoundland is biologically active and characterized by high levels of primary production (Longhurst 1981). The mechanisms maintaining such high levels of productivity are poorly understood, but may be linked to the physical and biological characteristics of the shelf break, where patches of nutrient rich water can form and intrude onto the shelf. Such intrusions are an important feature of other shelf/slope regimes (e.g. Fournier et al. 1977; Fournier 1978; Denman et al. 1980; Gardner 1982), but have not yet been demonstrated on the Grand Banks. The shelf break at the eastern margin of the Newfoundland Grand Banks is characterized by a frontal zone and by strong southerly flow along the slope due to the offshore branch of the Labrador Current (Mountain 1980; Petrie 1981). This current and associated front have been shown to meander onto the Southeast Shoal of the Grand Banks (Hayes and Robe 1978), but the temporal and spatial extent, and the overall effect, of such meanders is not known. The Southeast Shoal is of particular interest as it is an important breeding area for the yellowtail flounder and for capelin (Pitt 1958, 1970).

Researchers from the Northwest Atlantic Fisheries Center and from Memorial University of Newfoundland are engaged in a cooperative programme to evaluate the role of shelf break dynamics in the productivity of the adjacent shelf, and to test the hypothesis that frontal processes associated with the shelf break determine growth and survival of larval yellowtail flounder. The definition of the biological and physical regime across the shelf break is an important part of this study. Here, we discuss zooplankton distribution patterns within a grid of stations arrayed across the shelf break of the Southeast Shoal. The zooplankton data will later be interfaced with hydrographic and ichthyoplankton data to provide a general picture of the bio-oceanography of the study site in Spring 1981.

MATERIALS AND METHODS

In May 1981, zooplankton samples were collected from 27 sites on a grid stretching across the shelf break of the Southeast Shoal (Table 1; Fig. 1). Paired samples were collected by oblique tows using 61 cm mouth diameter bongo nets equipped with flowmeters and constructed of 333 m mesh Nitex netting. One sample from each pair was randomly selected for processing and sorted for ichthyoplankton by Northwest Atlantic Fisheries Center personnel; the ichthyoplankton data will form a separate report. After removal of ichthyoplankton, the samples were made available for sorting of all other zooplankton.

All samples were treated identically. Zooplankton displacement volumes were measured both with and without the gelatinous zooplankters, and the whole sample was inspected visually to allow removal of large zooplankters and break up aggregations of material that might bias subsampling. The samples were then split into progressively smaller aliquots using a Folsom Plankton Splitter until the smallest aliquot (no smaller than 1/512) contained about 100

Table 1. Station locations, depths and sample times. Final column shows station rankings by bottom depth (for calculation of Spearmann Rank Correlation Coefficient).

Date	Time (z)	Station	North Latitude	West Longitude	Bottom Depth (m)	Rank by Depth
May 17	1959	18	45°05'	50°30'	62	13
	2305	19	"	50°16'	59	15.5
May 18	0020	20	"	50°02'	57	18.5
	0200	21	"	49°47'	56	20
	0329	22	"	49°34'	59	15.5
	0545	23	"	49°20'	66	10
	0738	24	"	49°06'	65	11
	1020	25	"	48°50'	471	5
	1139	26	"	48°38'	1500+	*
	1424	27	44°55'	48°38'	1700+	1
	1605	28	"	48°52'	1380	4
	1915	29	"	49°06'	410	6
	2036	30	"	49°20'	100	8
	2225	31	"	49°34'	70	9
	2328	32	"	49°48'	60	14
May 19	0108	33	"	50°01'	55	21
	0240	34	"	50°16'	53	23
	0432	35	"	50°31'	57	18.5
	0558	36	44°45'	50°30'	54	22
	0754	37	"	50°16'	52	*
	0912	38	"	50°02'	50	24
	1050	39	"	49°48'	53	*
	1215	40	"	49°34'	58	17
	1437	41	"	49°20'	63	12
	1816	42AS	"	49°06'	224	7
	1935	43	"	48°50'	1500+	2.5
	2313	44	"	48°39'	1500+	2.5

*Station not used for Spearmann Rank Correlation

specimens of the dominant taxon. This and other abundant taxa were completely enumerated in the smallest aliquot, whereas less numerous taxa were counted from successively larger subsamples. Taxa were identified as completely as possible using available literature, and some copepod species were also sorted by life history stage. All counts were converted to estimated total number within the sample. The volume of water filtered was then used to calculate the number of organisms per cubic meter and the number of organisms under a square meter of surface down to the deepest depth sampled. All data were transformed ($x' = \ln (x + 1)$) and analysed by sample and by taxa using Detrended Correspondence Analysis (DCA: Hill 1979). Station rankings by depth and by per cent volume of non-gelatinous zooplankton were compared by
the Spearman Rank Correlation Coefficient (Snedecor and Cochran 1967).

RESULTS

Some 56 taxa, including 35 species, were identified and enumerated (Table 2). Settled volumes varied from 26 to 582 ml (Table 3). Complete data are reported in Appendix I. Direct observation of the samples indicated two dominant sample types - a group dominated by gelatinous zooplankters, primarily Pleurobrachia pileus, and a group dominated by crustacean zooplankters, primarily copepods. The latter group was typical of the deeper stations seaward of the shelf break, whereas the former group typified the shallow water stations on the continental shelf.

Detrended Correspondence Analysis of samples confirmed the visual observations, in that most sample variance was associated with a single axis, and along that axis stations fell into groups consistent with their position with respect to the shelf break (Fig. 2). The five stations (26, 27, 28, 43, 44) with the highest ranking on Axis 1 are those stations east of the 1000 m depth contour. Stations 25, 29 and 42, which are also grouped along Axis 1, are on the shelf break between the 200 and 1000 m contours. The stations ranking lowest on Axis 1 are those on the shallower end of the sampling grid (<60 m bottom depth).

The associated DCA of species showed a similar trend, separating deep water from shallow water species along the first axis (Fig. 3). Species grouped at either extremity of Axis 1 tended to be those found in a small proportion of the samples, while those with loadings between +100 and +300 tended to be those species ubiquitous in the study area. The species ranking lowest (-300 to 0) on Axis 1 are rare species which occurred only on the shallower end of the grid. Tomopteris planktonis, for example, was found only at station 36; Staurophora mertensi was found only at station 34; Temora longicornis was most abundant at stations 19, 36, 34 and 35; and Pleurobranchia pileus was most abundant at stations 21, 19, 35, 20, 22, 18 and 36 (listed in order of decreasing abundance). Those species ranking highest on Axis 1 were also rare, but tended to occur in the offshore stations. For example, Nematoscelis megalops was found only at station 44; Metridia lucens was found only at stations 43, 27 and 28; Limacina retroversa was found only at stations 44 and 43; and Euchaeta

Table 2. List of identified taxa and primary identification sources.

TAXA	IDENTIFICATION SOURCE
Hydrozoa	
Aglantha digitale (O.F. Muller 1776)	Shih 1977
Euphysa aurata Forbes 1848	Shih 1977
E. flammea (Linko 1905)	" "
Leuckartiara octona (Fleming 1823)	" "
Staurophora mertensi Brandt 1838	" "
Ctenophora	
Pleurobrachia pileus (O.F. Muller 1776)	Mayer 1912
Chaetognatha	
Sagitta sp.	Fraser 1957
S. elegans Verrill 1873	" "
S. maxima (Conant 1896)	" "
Eukrohnia hamata (Mobius 1875)	" "
Mollusca	
Limacina helicina (Phipps 1774)	van der Spoel 1972
L. retroversa Fleming 1823	" " " "
Clione limacina (Phipps 1774)	Morton 1957
Clione sp.	" "
Gonatus fabricii (Lichtenstein)	C. Morris, Memorial University, Pers. Comm.
Polychaeta	
Tomopteris helgolandica Greef 1879	Muus 1953
T. planktonis Apstein 1900	" "
Proceraea sp.	Hamond 1967
Ostracoda	
Conchoecia sp.	Poulsen 1969
Copepoda	
Calanus sp.	
Calanus finmarchicus s. l. *	Harding MS.; Murphy and Cohen MS.
C. helgolandicus (Claus 1863)	" " " " " "
C. hyperboreus Kroyer 1838	" " " " " "
Pseudocalanus sp.	Farran and Vervoort 1951
Microcalanus pygmaeus (G.O. Sars 1900)	" " " "
Euchaeta sp.	Harding MS.
Euchaeta norvegica Boeck 1972	" "
Centropages hamatus (Lilljeborg 1853)	Farran 1948
Temora longicornis (Muller 1785)	Harding MS.

Metridia sp.	
Metridia longa (Lubbock 1854)	Farran 1948
M. Lucens Boeck 1864	" "
Acartia longiremis (Lilljeborg 1853)	" "
Oithona similis Claus 1866	Murphy and Cohen MS; Gardner and Szabo 1982
Oncaea sp.	Murphy and Cohen MS; Gardner and Szabo 1982
Monstrilla sp.	Gardner and Szabo 1982

Amphipods

Hyperoche medusarum (Kroyer 1838)	Dunbar 1963
Parathemisto gaudichaudi (Guerin 1825)	" "
Parathemisto sp.	" "
Eusiridae	Barnard 1969
Gammaridae	" "
Lysianassidae	" "
Oedicerotidae	" "
Caprellidae	" "

Euphausiacea

Meganyctiphanes norvegica (M. Sars 1857)	Mauchline 1971
Thysanoessa inermis (Kroyer 1846)	" "
Th. raschii (M. Sars 1864)	" "
Th. longicaudata (Kroyer 1846)	" "
Nematoscelis megalops G.O. Sars 1883	" "

Larvaceans

Fritillaria borealis Lohmann 1896	Mahoney 1981
Oikopleura sp.	" "

* C. finmarchicus s.l. includes both C. finmarchicus (Gunnerus 1765) and C. glacialis Yaschnov 1955, which are not readily separable in batch sample, and may represent slightly different forms of the same species.

Note: some taxa identified only to very broad groups (e.g. isopods, hirudinea) have not been included in this table.

Table 3. Distribution of total settled volume (TSV) between gelatinous and non-gelatinous fractions, and station rankings by per cent non-gelatinous taxa.

Station	Non-gelatinous zooplankton*			Gelatinous zooplankton*		Total settled
	vol.(ml)	%TSV	rank	vol.(ml)	%TSV	volume (ml)
18	2.0	0.9	24	214.0	99.1	216.0
19	15.0	17.9	19	69.0	82.1	84.0
20	4.0	14.3	21	24.0	85.7	28.0
21	7.0	14.9	20	40.0	85.1	47.0
22	20.0	38.5	14	32.0	61.5	52.0
23	108.0	60.3	11	71.0	39.7	179.0
24	118.0	93.7	9	8.0	6.3	126.0
25	350.0	100.0	4	NIL	-0-	350.0
26	___	___	___	___	___	223.0
27	582.0	100.0	4	NIL	-0-	582.0
28	223.0	100.0	4	NIL	-0-	223.0
29	380.0	98.7	8	5.0	2.3	385.0
30	112.0	100.0	4	NIL	-0-	112.0
31	40.0	42.6	13	54.0	57.4	94.0
32	13.0	13.8	22	81.0	86.2	94.0
33	7.0	12.7	23	48.0	87.3	55.0
34	20.0	44.4	12	45.0	55.6	65.0
35	16.0	28.1	16	41.0	71.9	57.0
36	10.0	21.7	18	36.0	78.3	46.0
37	7.0	___	___	___	___	___
38	9.0	34.6	15	17.0	65.4	26.0
39	3.0	___	___	___	___	___
40	7.0	25.0	17	21.0	75.0	28.0
41	68.0	78.2	10	19.0	21.8	87.0
42A	97.0	100.0	4	NIL	-0-	97.0
43	540.0	100.0	4	NIL	-0-	540.0
44	282.0	100.0	4	NIL	-0-	282.0

*a negligible volume of smaller gelatinous zooplankters were likely included in the non-gelatinous fraction.

norvegica was found only at stations 44, 27, 43, 42, 28 and 25 (listed in order of decreasing abundance). In addition, the analysis by species showed increasing variability, manifested by a greater scatter along the second axis, among the shallower stations (Fig. 3). There is no obvious significance to the second axis. The Spearmann Rank Correlation Coefficient between stations ranked by depth (Table 1) and by relative volumetric importance of non-gelatinous zooplankters (Table 3) was 0.78 (significant at $p < 0.01$; d.f. = 22).

DISCUSSION

The Labrador Current and its associated frontal zone act as a natural boundary between the continental shelf and slope regimes along the eastern edge of the Newfoundland Grand Banks. This separation in physical regimes is reflected in the distribution of zooplankton. Stations east of the shelf break are more oceanic in nature, while those west of the shelf break are more neritic. The area immediately over the shelf break also has a zooplankton community which is different from stations at either end of the grid. The observed differences in community composition are not complete, in that many species are ubiquitous in the study area; nevertheless, appropriate community analysis techniques such as Detrended Correspondence Analysis show differences between stations within the sampling grid. The primary determinant of zooplankton community composition is clearly station position with respect to the shelf break; however, differences between onshore and offshore stations are also reflected in the higher variability at stations over the shelf, and in higher settled volumes of non-gelatinous zooplankters over the slope.

The gelatinous zooplankters which dominated the shelf stations in this study represent a metabolic 'dead end'. They are too large to be consumed by ichthyoplankton, and their high water content suggests that they are not a good source of food for planktivorous nekton. Furthermore, Pleurobrachia is an important predator which can greatly reduce zooplankton populations, indirectly causing larval fish mortalities (Fraser 1970) and affecting the trophic structure of the local marine ecosystem (e.g. Greve and Reiners 1980). Conversely, the oceanic water has high concentrations of both small and large zooplankters, and might be considered nutritionally more appropriate for ichthyoplankton and larger planktivores. We hypothesize that advection of this plankton-rich oceanic water onto the shelf would represent an important source of food for planktivorous organisms there. Further, we suggest that such intruding water would bring nutrients onto the shelf and thus enhance primary productivity, as occurs off Nova Scotia on the Scotian Shelf (Fournier et al. 1977).

These hypotheses are not supported by the zooplankton data collected in May 1981; however, the results presented here are only a single snapshot of a dynamic area. The observed differences in the zooplankton community on either side of the shelf break suggest that advection of slope water onto the shelf, in the sense observed by Hayes and Robe (1978), would result in changes in the shelf zooplankton. Such community changes might then be used to indicate the presence and extent of advection (e.g. Gardner 1982).

Further studies of the zooplankton, ichthyoplankton, primary production and synoptic oceanography of the Southeast Shoal will more clearly define the biological oceanographic processes which dominate the area. The dynamics of such processes are important to our understanding of continental shelf productivity, and ultimately to our understanding of the processes controlling recruitment and survival of commercial fish species on the Grand Banks.

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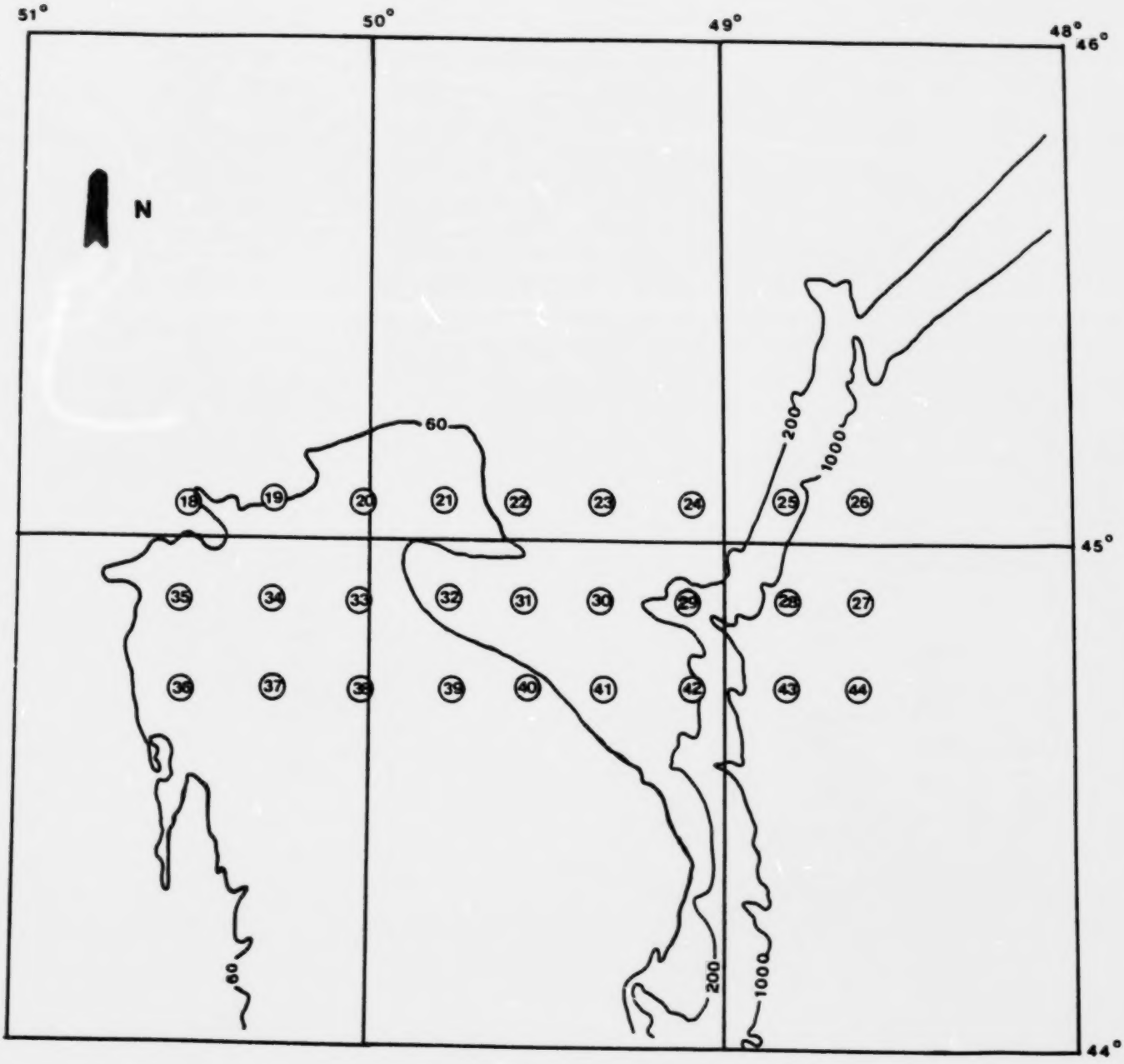

Figure 1. Bathymetry of study area and location of sampling stations.

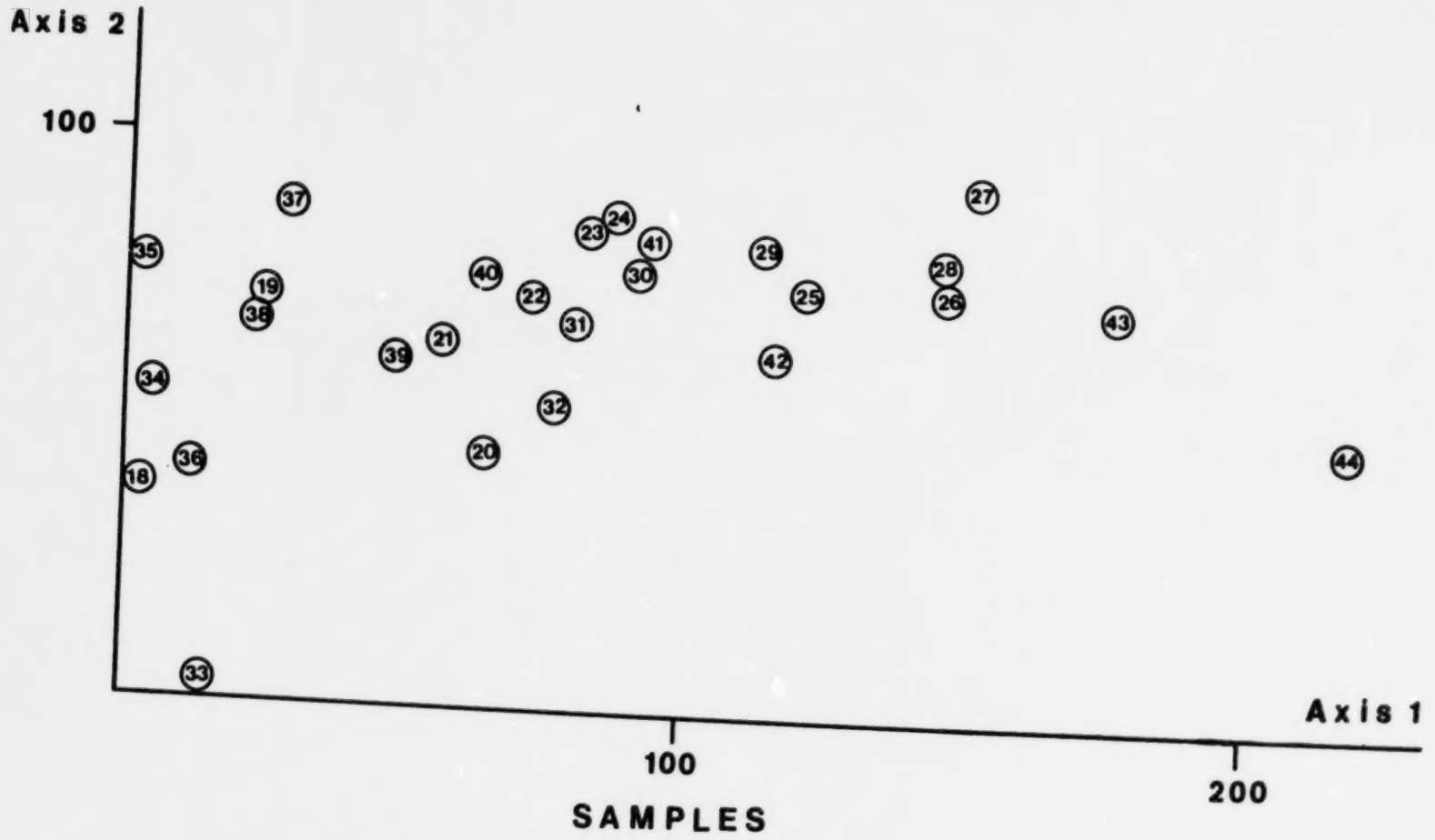

Figure 2. Plot of stations with respect to loadings on Axis 1 and Axis 2 of Detrended Correspondence Analysis.

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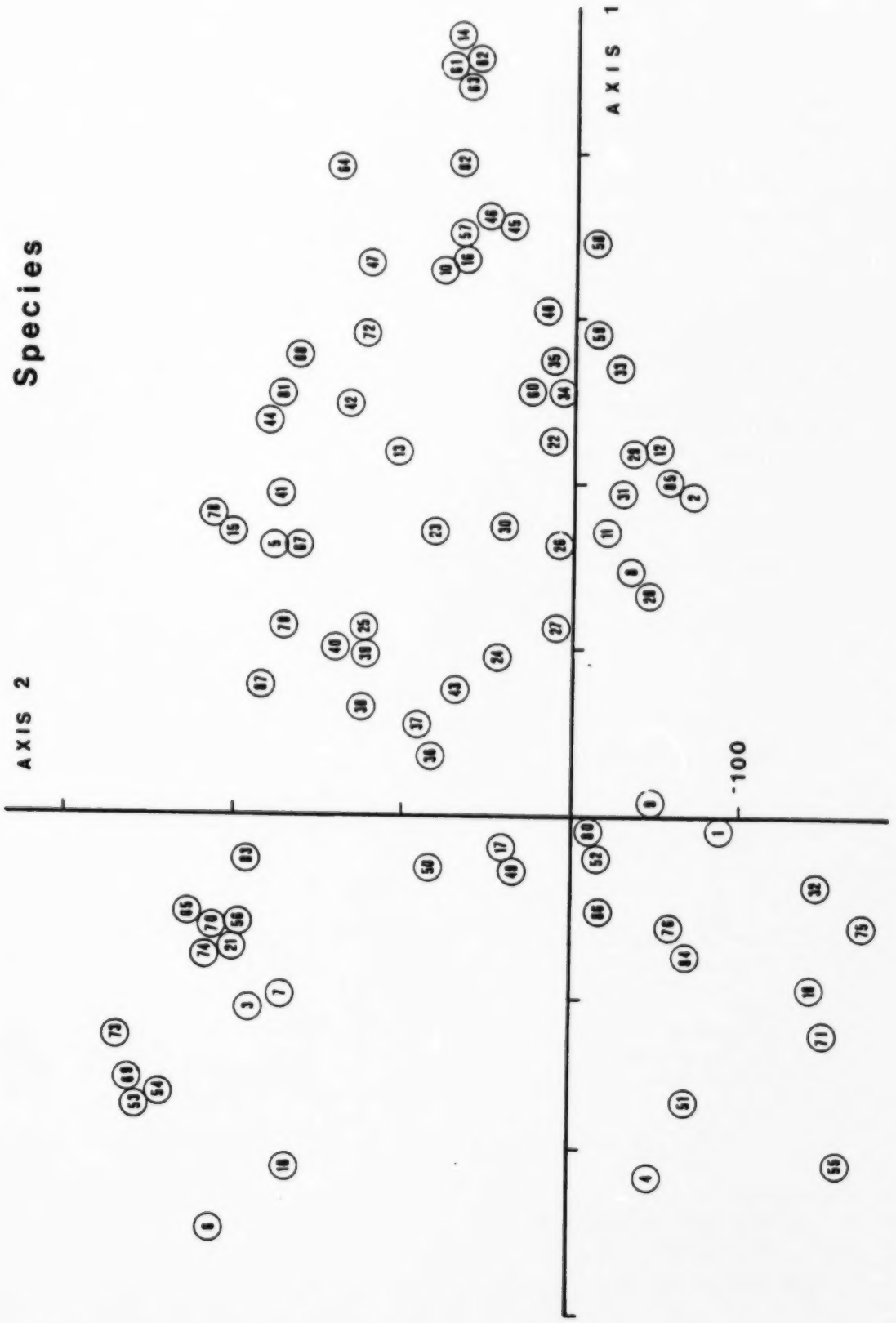
Figure 3. Plot of all identified taxa with respect to loadings on Axis 1 and Axis 2 of Detrended Correspondence Analysis. Axis gradations are in units of 100; code numbers as indicated below:

1. Euphysa aurata
2. E. flammea
3. Leuckartiara octona
4. Staurophora mertensi
5. Aglantha digitale
6. Unidentified scyphozoan
7. Pleurobranchia pileus
8. Unidentified ctenophore fragments
9. Sagitta elegans
10. S. maxima
11. Eukrohnia hamata
12. Unidentified chaetognath fragments
13. Limacina helicina
14. L. retroversa
15. Clione limacina
16. Gonatus fabricii
17. Tomopteris helgolandica
18. T. planktonis
19. Procerae sp.
20. Benthic sp.
21. Unidentified hirudinean
22. Conchoecia sp.
23. Calanus sp. CIV
24. " " CIII
25. " " CII
26. " " CI
27. " " TOTAL CI-CIV
28. C. finmarchicus CVIm
29. " " CVIf
30. " " CV
31. " " total CV/VI
32. C. hyperboreus CVIm
33. " " CVIf
34. " " CV
35. " " total CV/VI
36. Pseudocalanus sp. CVIm
37. " " CVIf
38. " " CVm
39. " " CVf
40. " " CIV
41. " " CIII
42. " " CI+CII
43. " " TOTAL CI+CVI
44. Microcalanus pygmaeus
45. Euchaeta norvegica CVIm
46. E. norvegica CVIf
47. E. " CI-CV
48. E. " Total CI-CVI
49. Centropages hamatus CVIm
50. C. hamatus CVIf
51. " " copepodites
52. " " Total
53. Temora longicornis CVIm
54. T. longicornis CVIf
55. " " copepodites
56. " " Total
57. Metridia longa CVIm
58. M. longa CVIf
59. " " copepodites
60. " " Total
61. M. lucens CVIm
62. " " CVIf
63. " " copepodites
64. " " Total
65. Acartia longiremis
66. Unidentified harpacticoid
67. Oithona similis
68. Oncaea sp.
69. Monstrilla sp.
70. Unidentified isopod
71. Hyperoche medusarum
72. Parathemisto gaudichaudi
73. Gammaridea
74. Eusiridae
75. Lysianassidae
76. Oedicerotidae
77. Caprellidae
78. Meganyctiphanes norvegica
79. Thysanoessa inermis
80. T. raschii
81. T. longicaudata
82. Nematoscelis megalops
83. Unidentified larval euphausiids
84. Unidentified decapod larvae
85. " ophiuroid
86. Fritillaria borealis
87. Oikopleura sp.


Species
AXIS 2
AXIS 1
-100

APPENDIX 1

Cruise No.: G51 Sample serial no.: 18L
Station: 45°05'N 50°30'W
Date: 5/16/81

Tow depth: 57m
Bottom depth: 62m
Mesh size: 333µm
Volume filtered: 214.7m^3

		Estimated total number	No./m^3	No./m^2
Ctenophora				
Pleurobrachia pileus		582.0	2.7	154.5
Polychaeta				
Tomopteris helgolandica		13.0	0.1	3.4
Copepoda				
Calanus spp.	IV	6.0	0.03	1.7
	III	6.0	0.03	1.7
	II	8.0	0.03	1.7
	Total:	20.0	0.1	5.1
Pseudocalanus spp.	VIm	9.0	0.04	2.3
	VIf	27.0	0.1	7.4
	Vm	16.0	0.1	4.0
	Vf	18.0	0.1	4.6
	IV	13.0	0.1	3.4
	III	2.0	0.01	0.6
	Total:	85.0	0.4	22.2
Centropages hamatus	VIm	10.0	0.1	2.9
	VIf	3.0	0.01	0.6
	Total:	13.0	0.1	3.4
Temora longicornis	VIm	5.0	0.02	1.1
	VIf	1.0	0.004	0.2
	Total:	6.0	0.02	1.3
Acartia longiremis		1.0	0.004	0.2
Oithona similis		13.0	0.1	3.4
Amphipods				
Gammaridea		1.0	0.004	0.2
Oedicerotidae		3.0	0.01	0.6
Caprellidae		14.0	0.1	4.0
Euphausiacea				
Unidentified larval stages		8.0	0.04	2.3
Larvaceans				
Fritillaria borealis		10.0	0.1	2.9
Oikopleura spp.		1.0	0.004	0.2

DISPLACEMENT VOLUMES: without jelly: 2.0ml
with jelly: 216.0ml

Cruise No.: G51 Sample serial no.: 19R
Station: 45°05'N 50°15'W
Date: 17/5/81

Tow depth: 54m
Bottom depth: 59m
Mesh size: 333µm
Volume filtered: 46.97m^3

		Estimated total number	No./m^3	No./m^2
Hydrozoa				
Aglantha digitale		1.0	0.02	1.1
Ctenophora				
Pleurobrachia pileus		240.0	5.11	275.9
Chaetognatha				
Sagitta elegans		21.0	0.45	24.3
Eukrohnia hamata		5.0	0.11	5.9
Polychaeta				
Tomopteris helgolandica		21.0	0.45	24.3
Copepoda				
Calanus spp.	IV	119.4	2.54	137.2
	III	541.3	11.52	622.1
	II	31.8	0.68	36.7
	Total:	692.5	14.74	796.0
*Calanus finmarchicus**	VIm	2.0	0.04	2.2
	VIf	26.0	0.56	30.2
	V	22.0	0.47	25.4
	Total:	50.01	1.07	57.8
Pseudocalanus spp.	VIm	159.2	3.39	183.1
	VIf	1568.1	33.39	1803.1
	Vm	302.5	6.44	347.8
	Vf	334.3	7.12	384.5
	IV	254.7	5.42	292.7
	Total:	2618.8	55.76	3011.2
Centropages hamatus	VIm	557.2	11.9	640.4
	VIf	405.9	8.6	466.6
	V	39.8	0.9	4.6
	Total:	1002.9	21.4	1111.6
Temora longicornis	VIm	175.1	3.7	201.4
	VIf	183.0	3.9	210.6
	Total:	358.1	7.6	412.0
Oithona similis		23.8	0.5	27.5
Decapoda				
larval shrimp		4.0	0.1	4.9
Larvaceans				
Fritillaria borealis		253.6	5.4	291.6
Oikopleura spp.		1.0	0.02	1.1

DISPLACEMENT VOLUME: without jelly: 15.0ml
with jelly: 84.0ml

*Includes *Calanus glacialis*

Cruise No.: G51 Sample serial no.: 20R
Station: 45°05'N 50°02'W
Date: 05/18/81

Tow Depth: 52m
Bottom depth: 57m
Mesh size: 333µm
Volume filtered: 70.59m^3

		Estimated total number	No./m^3	No./m^2
Ctenophora				
Pleurobrachia pileus		249.0	3.53	183.6
Chaetognatha				
Sagitta elegans		7.0	0.10	5.2
Eukrohnia hamata		5.0	0.07	3.6
Gastropoda				
Limacina helicina		40.2	0.57	29.6
Polychaeta				
Tomopteris helgolandica		6.0	0.08	4.2
Proceraea sp.		4.0	0.06	3.12
Copepoda				
Calanus spp.	IV	348.7	4.94	256.9
	III	871.8	12.35	642.2
	II	95.1	1.35	70.2
	Total:	1315.6	18.64	969.3
Calanus finmarchicus	VIm	10.1	0.14	7.3
	VIf	34.2	0.48	25.0
	V	144.7	2.05	106.6
	Total:	189.0	2.67	138.8
Calanus hyperboreus	VIm	2.01	0.03	1.6
	V	2.01	0.03	1.6
	Total:	4.02	0.06	3.1
Pseudocalanus spp.	VIm	95.5	1.35	70.2
	VIf	453.7	6.43	334.4
	Vm	254.7	3.61	187.7
	Vf	262.7	3.72	193.4
	IV	246.7	3.50	182.0
	III	15.92	0.23	12.0
	Total:	1329.22	18.84	979.7
Centropages hamatus	VIm	254.7	3.61	187.7
	VIf	111.4	1.58	82.2
	Total:	366.1	5.19	269.9
Temora longicornis		8.04	0.11	5.7
Oithona similis		36.18	0.51	26.5
Decapod				
Larval Shrimp		6.0	0.08	4.2
Amphipoda				
Lysianassidae		12.0	0.17	8.8

Oedicerotidae	8.0	0.11	5.7
Larvacea			
Fritillaria borealis	507.2	7.19	373.9
Oikopleura spp.	31.7	0.45	23.4

DISPLACEMENT VOLUME: without jelly: 4.0ml
with jelly: 28.0ml

Cruise No.: G51 Sample serial no.: 21R
Station: 45°05'N 49°47'W
Date: 18/5/81

Tow depth: 51m
Bottom depth: 56m
Mesh size: 333µm
Volume filtered: 45.83m^3

		Estimated Total number	No./m^3	No./m^2
Hydrozoa				
Aglantha digitale		2.0	0.04	2.1
Ctenophora				
Pleurobrachia pileus		375.0	8.18	417.2
Chaetognatha				
Sagitta elegans		11.0	0.24	12.2
Gastropoda				
Limacina helicina		2.0	0.04	2.0
Polychaeta				
Tomopteris helgolandica		6.0	0.13	6.6
Hirudinea				
unidentified		1.0	0.02	1.0
Copepoda				
Calanus spp.	IV	364.0	7.94	404.9
	III	484.0	10.56	538.6
	II	36.0	0.79	40.3
	Total:	884.0	19.29	983.8
Calanus finmarchicus	VIm	4.0	0.09	4.6
	VIf	32.0	0.7	35.7
	V	128.0	2.79	142.3
	Total:	164.0	3.58	182.6
Pseudocalanus spp.	VIm	8.0	0.17	8.7
	VIf	148.0	3.23	164.7
	Vm	164.0	3.58	182.6
	Vf	200.0	4.36	222.4
	IV	57.0	1.24	63.3
	III	64.0	1.40	71.4
	Total:	641.0	13.98	713.0
Centropages hamatus	VIm	59.0	1.29	65.8
	VIf	24.0	0.52	26.5
	Total:	83.0	1.81	92.3
Temora longicornis		8.0	0.17	8.7
Metridia longa		2.0	0.04	2.0
Oithona similis		11.0	0.24	12.2
Amphipoda				
Gammaridea		2.0	0.04	2.0
Eursiridae		7.0	0.15	7.7
Lysianassidae		5.0	0.11	5.6
Oedicerotidae		5.0	0.11	5.6

Decapoda			
larval shrimp	5.0	0.11	5.6
Euphausiacea			
Thysanoessa raschii	1.0	0.02	1.0
Larvacea			
Fritillaria borealis	380.4	8.3	423.3

DISPLACEMENT VOLUME: without jelly: 7.0ml
with jelly: 47.0ml

Cruise No.: G51 Sample serial no.: 22L
Station: 45°05'N 49°34'W
Date: 18/5/81

Tow depth: 54m
Bottom depth: 59m
Mesh size: 333µm
Volume filtered: 106.7m^3

		Estimated total number	No./m^3	No./m^2
Ctenophora				
Pleurobrachia pileus		331.0	3.10	167.4
Chaetognatha				
Sagitta elegans		24.0	0.22	11.9
Gastropoda				
Limacina helicina		52.0	0.49	26.5
Ostracoda				
Conchoecia sp.		4.0	0.04	2.2
Copepoda				
Calanus spp.	IV	2397.8	22.47	1213.4
	III	2744.0	25.72	1388.9
	II	978.0	9.17	495.2
	Total:	6119.8	57.36	3097.4
Calanus finmarchicus	VIf	157.7	1.48	79.9
	V	1262.0	11.83	638.8
	Total:	1419.7	13.31	718.7
Calanus hyperboreus	V	31.5	0.3	16.2
Pseudocalanus spp.	VIm	94.65	0.89	48.1
	VIf	1072.0	10.05	542.7
	Vm	1293.0	12.12	654.5
	Vf	1451.3	13.6	734.4
	IV	1262.0	11.83	638.8
	Total:	5172.95	48.49	242.5
Centropages hamatus	VIm	441.7	4.14	223.6
	VIf	63.1	0.59	31.9
	V	94.7	0.89	48.1
	Total:	599.5	5.62	303.5
Temora longicornis	VIm	31.5	0.3	16.2
	VIf	31.5	0.3	16.2
	Total:	63.0	0.6	32.4
Metridia longa		16.0	0.15	8.1
Acartia longiremis		16.0	0.15	8.1
Oithona similis		283.9	2.66	143.6
Amphipoda				
Gammaridea		6.0	0.06	3.2
Oedicerotidae		3.0	0.03	1.6

Euphausiacea			
unidentified larvae	8.0	0.07	3.8
Decapoda			
Larval shrimp	4.0	0.04	2.2
Larvacea			
Fritillaria borealis	713.2	6.68	360.7
Oikopleura spp.	760.8	7.13	385.0

DISPLACEMENT VOLUME: without jelly: 20.0ml
with jelly: 52.0ml

Cruise No.: G51 Sample serial no.: 23L
Station: 45°05'N 49°20'W
Date: 18/5/81

Tow depth: 60m
Bottom depth: 66m
Mesh size: 333µm
Volume filtered: 161.22m^3

		Estimated total number	No./m^3	No./m^2
Hydrozoa				
Aglantha digitale		46.0	0.29	17.4
Ctenophora				
Pleurobrachia pileus		258.0	1.60	96.0
Chaetognatha				
Sagitta elegans		20.0	0.12	7.2
Eukrohnia hamata		1.0	0.01	0.6
Gastropoda				
Limacina helicina		1758.0	10.90	654.0
Polychaeta				
Tomopteris helgolandica		10.0	0.06	3.6
Copepoda				
Calanus spp.	IV	1500.0	9.3	558.0
	III	4000.0	24.81	1488.6
	II	11375.0	70.56	4233.6
	I	6375.0	39.54	2372.4
	Total:	23250.0	144.21	8652.6
Calanus finmarchicus	VIf	95.5	0.59	35.4
	V	429.8	2.67	160.2
	Total:	525.3	3.26	195.6
Pseudocalanus spp.	VIm	2500.0	15.51	930.6
	VIf	2875.0	17.83	1069.8
	Vm	1750.0	10.85	651.0
	Vf	4625.0	28.69	1721.4
	IV	7375.0	45.74	2744.4
	III	2000.0	12.41	744.6
	II	375.0	2.33	139.8
	Total:	21,500.0	133.36	8001.6
Microcalanus pygmaeus		62.8	0.39	23.4
Centropages hamatus	VIm	3125.0	19.38	1162.8
	VIf	1125.0	6.98	418.8
	Total:	4250.0	26.36	1581.6
Temora longicornis		188.4	1.17	70.2
Metridia longa		55.7	0.35	21.0
Acartia longiremis		314.0	1.95	117.0
Oithona similis		14625.0	90.71	5442.6
Amphipoda				
Parathemisto gaudichaudi		1.0	0.01	0.6
Gammaridea		2.0	0.01	0.6

Euphausiacea			
Euphausiid larvae	879.2	5.45	327.0
Thysanoessa raschii	32.0	0.20	12.0
Thysanoessa inermis	1.0	0.01	0.6
Decapoda			
Larval shrimp	2.0	0.01	0.6
Larvacea			
Fritillaria borealis	6625.0	41.09	2465.4
Oikopleura spp.	4750.0	29.46	1767.6

DISPLACEMENT VOLUME: without jelly: 108.0ml
with jelly: 179.0ml

Cruise No.: G51 Sample serial no.: 24L
Station: 45°05'N 49°06'W
Date: 18/5/81

Tow depth: 60m*
Bottom depth: 65m
Mesh size: 333µm
Volume filtered: 139.96m^3

		Estimated total number	No./m^3	No./m^2
Hydrozoa				
Euphysa aurata		1.0	0.01	0.6
Leuckartiara octona		1.0	0.01	0.6
Aglantha digitale		9.0	0.06	3.6
Ctenophora				
Pleurobrachia pileus		9.0	0.06	3.6
Chaetognatha				
Sagitta elegans		6.0	0.04	2.4
Gastropoda				
Limacina helicina		262.3	1.87	112.2
Polychaeta				
Tomopteris helgolandica		6.0	0.04	2.4
Proceraea sp.		255.6	1.83	109.8
Ostracoda				
Conchoecia sp.		7.96	0.06	3.6
Copepoda				
Calanus spp.	IV	1884.0	13.46	807.6
	III	4898.4	35.0	2100.0
	II	6782.4	48.46	2907.6
	I	3454.0	24.68	1480.8
	Total:	17018.8	121.6	7296.0
Calanus finmarchicus	Vf	23.9	0.2	10.2
	V	72.0	0.5	30.0
	Total:	95.9	0.7	40.2
Pseudocalanus spp.	VIm	1004.8	7.2	430.8
	VIf	2574.8	18.4	1104.0
	Vm	2637.6	18.9	1134.0
	Vf	1256.0	9.00	538.2
	IV	11115.0	79.4	4765.2
	III	5589.0	39.9	2394.0
	II	565.2	4.0	242.4
	Total:	24742.4	176.8	10608.6
Centropages hamatus		538.9	3.9	231.0
Temora longicornis		15.9	0.1	6.6
Metridia longa		95.5	0.7	40.8
Acartia longiremis		697.4	5.0	298.8
Oithona similis		10738.0	76.7	4603.2
Amphipoda				
Parathemisto gaudichaudi		5.0	0.04	2.4

* estimated, not recorded

Euphausiacea			
Euphasiid larvae	612.9	4.38	262.8
Decapods			
Larval shrimp	2.0	0.01	0.6
Larvacea			
Fritillaria borealis	16390.8	117.11	7026.6
Oikopleura spp.	5777.6	41.28	2476.8

DISPLACEMENT VOLUME: without jelly: 118.0ml
with jelly: 126.0ml

Cruise No.: G51 Sample serial no.: 25L
Station: 45°05'N 48°50'W
Date: 18/5/81

Tow depth: 200m
Bottom depth: 471m
Mesh size: 333µm
Volume filtered: 357.05m^3

		Estimated total number	No./m^3	No./m^2
Hydrozoa				
Aglantha digitale		109.6	0.31	62.0
Ctenophora				
Fragments (estimated no. individuals)		2.0	0.01	2.0
Chaetognatha				
Sagitta elegans		312.0	0.87	174.0
Eukrohnia hamata		71.0	0.20	40.0
Gastropoda				
Limacina helicina		6500.0	18.2	3640.0
Polychaeta				
Tomopteris helgolandica		2.0	0.01	2.0
Ostracoda				
Conchoecia sp.		125.0	0.35	70.0
Copepoda				
Calanus spp.	IV	7923.0	22.19	4438.0
	III	13866.0	38.84	7768.0
	II	24266.0	67.96	13592.0
	I	30704.0	85.99	17198.0
	Total:	76759.0	214.98	42996.0
Calanus finmarchicus	VIm	315.0	0.88	176.0
	VIf	6152.0	17.23	3446.0
	V	1798.0	5.04	1008.0
	Total:	8265.0	23.15	4630.0
Calanus hyperboreus	V	820.3	2.30	460.0
Pseudocalanus spp.	VIm	5942.0	16.64	3328.0
	VIf	17828.0	49.93	9986.0
	Vm	11885.0	33.29	6658.0
	Vf	22285.0	62.41	12482.0
	IV	22780.0	63.8	12760.0
	III	10895.0	30.51	6102.0
	II & I	4952.0	13.87	2774.0
	Total:	97387.3	272.75	54550.0
Centropages hamatus	VIm	7713.0	21.6	4320.0
	VIf	9703.0	27.2	5436.0
	Total:	17416.0	48.8	9756.0
Microcalanus pygmaeus	VIm	690.0	1.9	386.0
	VIf	1130.0	3.2	634.0
	Total:	1820.0	5.1	1020.0

Temora longicornis	125.0	0.35	70.0
Acartia longiremis	62.8	0.18	36.0
Euchaeta norvegica	11.0	0.03	5.0
Metridia longa VIm	62.8	0.2	36.0
VIf	1004.8	2.8	562.0
V-I	251.0	0.7	140.0
Total:	1318.6	3.7	738.0
Oithona similis	82703.0	231.63	46326.0
Oncaea sp.	990.0	2.77	554.0
Amphipoda			
Parathemisto gaudichaudi	3533.0	9.89	1978.0
Euphausiacea			
Thysanoessa rashii	1.0	0.003	0.6
Thysanoessa longicaudata	1.0	0.003	0.6
Decapoda			
Larval shrimp	2.0	0.01	2.0
Larvacea			
Fritillaria borealis	6375.0	17.85	3570.0
Oikopleura spp.	6750.0	18.90	3780.0

DISPLACEMENT VOLUME: with jelly: 350.0ml

NOTE: so little jelly that volume without was not determined.

Cruise No.: G51 Sample serial no.: 26R
Station: 45°05'N 48°38'W
Date: 18/5/81

Tow depth: 200m
Bottom depth: > 1500m
Mesh size: 333µm
Volume filtered: 367.68m^3

	Estimated total number	No./m^3	No./m^2
Hydrozoa			
Aglantha digitale	2.0	0.01	2.0
Chaetognatha			
Sagitta elegans	467.9	1.27	254.0
Sagitta maxima	4.0	0.01	2.0
Eukrohnia hamata	192.0	0.52	104.0
Unidentified fragments	38.0	0.10	20.0
Gastropoda			
Limacina helicina	1090.0	2.96	5.9
Ostracoda			
Conchoecia sp.	125.6	0.34	68.0
Copepoda			
Calanus spp. IV	9205.0	25.04	5008.0
III	17914.0	48.72	9744.0
II	6220.0	16.92	3384.0
I	4727.0	12.86	2572.0
Decomposing (IV-I)	16919.0	46.02	9204.0
Total:	54985.0	149.56	29912.0
Calanus finmarchicus VIf	2260.0	6.15	1230.0
V	1256.0	3.42	684.0
Total:	3516.0	9.57	1914.0
Calanus hyperboreus VIf	62.8	0.17	34.0
V	2449.0	6.66	1332.0
Total:	2511.8	6.83	1366.0
Decomposed *C. finmarchicus* (IV-V) + *C. hyperboreus* (IV-V)	2488.0	6.77	1354.0
Pseudocalanus spp. VIm	1741.0	4.74	948.0
VIf	2736.0	7.44	1488.0
Vm	1990.0	5.41	1082.0
Vf	6469.0	17.59	3518.0
IV	14928.0	40.6	8120.0
III	4727.0	12.86	2572.0
II	1244.0	3.38	676.0
Decomposed (V-VI)	19158.0	52.11	10422.0
Decomposed (IV-V)	6469.0	17.59	3518.0
Total:	59462.0	161.72	32344.0
Centropages hamatus	125.6	0.34	68.0
Oithona similis	18660.0	50.75	10150.0
Decomposing II	3980.0	10.83	2166.0
Total:	22640.0	61.58	12316.0

POOR

QUALITY

ORIGINAL